Appendix A. Supporting Figures for Section 3.2.2 (Model Results)

These animations (**Figures A-1 through A-9**) provide context for the still images shown in Section 3.2.2.

Figure A-1. RAQMS-modeled ozone at the 300 K isentrope-level from May 3 at 12:00 UTC to May 8 at 12:00 UTC. The model was initialized at 12:00 UTC on May 3.

Figure A-2. RAQMS-modeled ozone at the 300 K isentrope-level from May 6 at 12:00 UTC to May 11 at 12:00 UTC. The model was initialized at 12:00 UTC on May 6.

Figure A-3. RAQMS-modeled ozone at the 310 K isentrope-level from May 3 at 12:00 UTC to May 8 at 12:00 UTC. The model was initialized at 12:00 UTC on May 3.

Figure A-4. RAQMS-modeled cross-section of ozone from May 3 at 12:00 UTC to May 8 at 12:00 UTC. The model was initialized at 12:00 UTC on May 3. The red box represents the approximate area of stratospheric intrusion.

Figure A-5. RAQMS-modeled CO at the 310 K isentrope-level from May 3 at 12:00 UTC to May 8 at 12:00 UTC. The model was initialized at 12:00 UTC on May 3.

Figure A-6. RAQMS-modeled cross-section of CO from May 3 at 12:00 UTC to May 8 at 12:00 UTC. The model was initialized at 12:00 UTC on May 3.

Figure A-7. RAQMS-modeled cross-section of CO from May 6 at 12:00 UTC to May 11 at 12:00 UTC. The model was initialized at 12:00 UTC on May 6.

Figure A-8. Stratospheric ozone from May 3 at 00:00 UTC to May 4 at 18:00 UTC.

Figure A-9. WACCM-modeled ozone at the 500 mb level with a minimum contour of 60 ppb and a maximum contour of 140 ppb on May 4 at 0:00 UTC to May 7 at 06:00 UTC.

Figures A-10 through A-14 depict the stratospheric ozone (O3S) tracer time series and correspond to the WACCM latitudinal cross sections of total ozone concentrations in Figures 3-24 through 3-28 in Section 3.2.2. The modeled O3S cross section profiles indicate a persistent feature along the transport path to Clark County. Due to the expected chemical and dry deposition losses of a stratospheric ozone contribution during multi-day transport, the O3S values decrease over time leading up to the event day. This positive detection of stratospheric influence is within the range of SOI episodes detected previously. Chouza et al. 2020 report comparable values for the stratospheric ozone tracer in the WACCM model near Clark County (15-20 ppb in the boundary layer during the May 6 event), with a typical interquartile range including exceptional SOI event days during late spring 2019 and 2020. Furthermore, the total ozone bias in WACCM is typically +20% or less near the surface (Chouza et al., 2020). Overall, the WACCM model results provide evidence for a detectable stratospheric ozone influence on May 6, 2020, in Clark County.

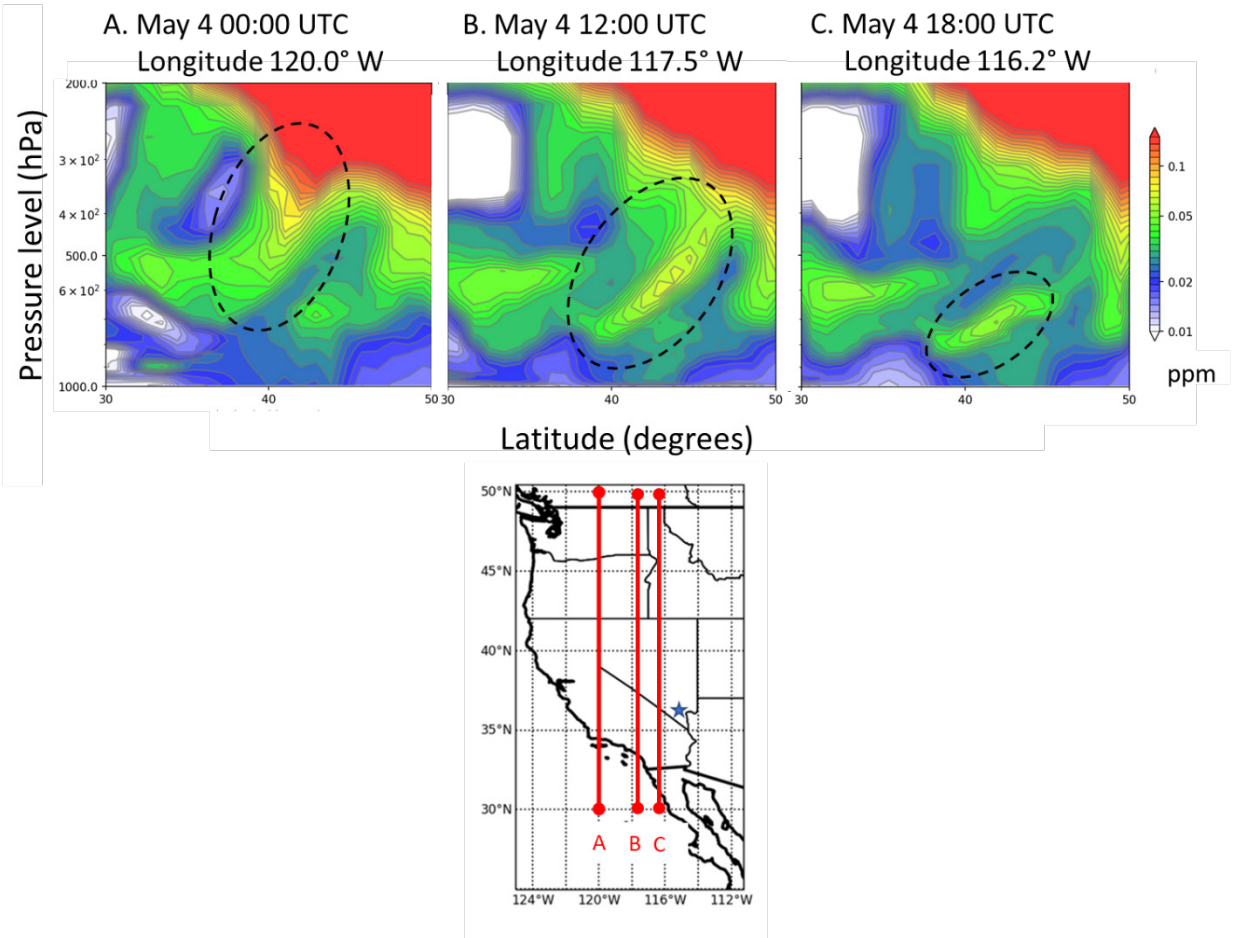

Figure A-10. WACCM-modelled cross-section of the stratospheric ozone tracer along the (A) 120-degrees W longitude line on May 4 at 00:00 UTC, (B) 117.5-degrees W longitude line on May 4 at 12:00 UTC, and (C) 116.2-degrees W longitude line on May 4 at 18:00 UTC. Ozone injected from the proposed source of stratospheric ozone on May 4, 00:00 UTC is circled in black in each plot. The extent of the cross-section is represented by the red line on the map (bottom). Las Vegas is represented by a blue star.

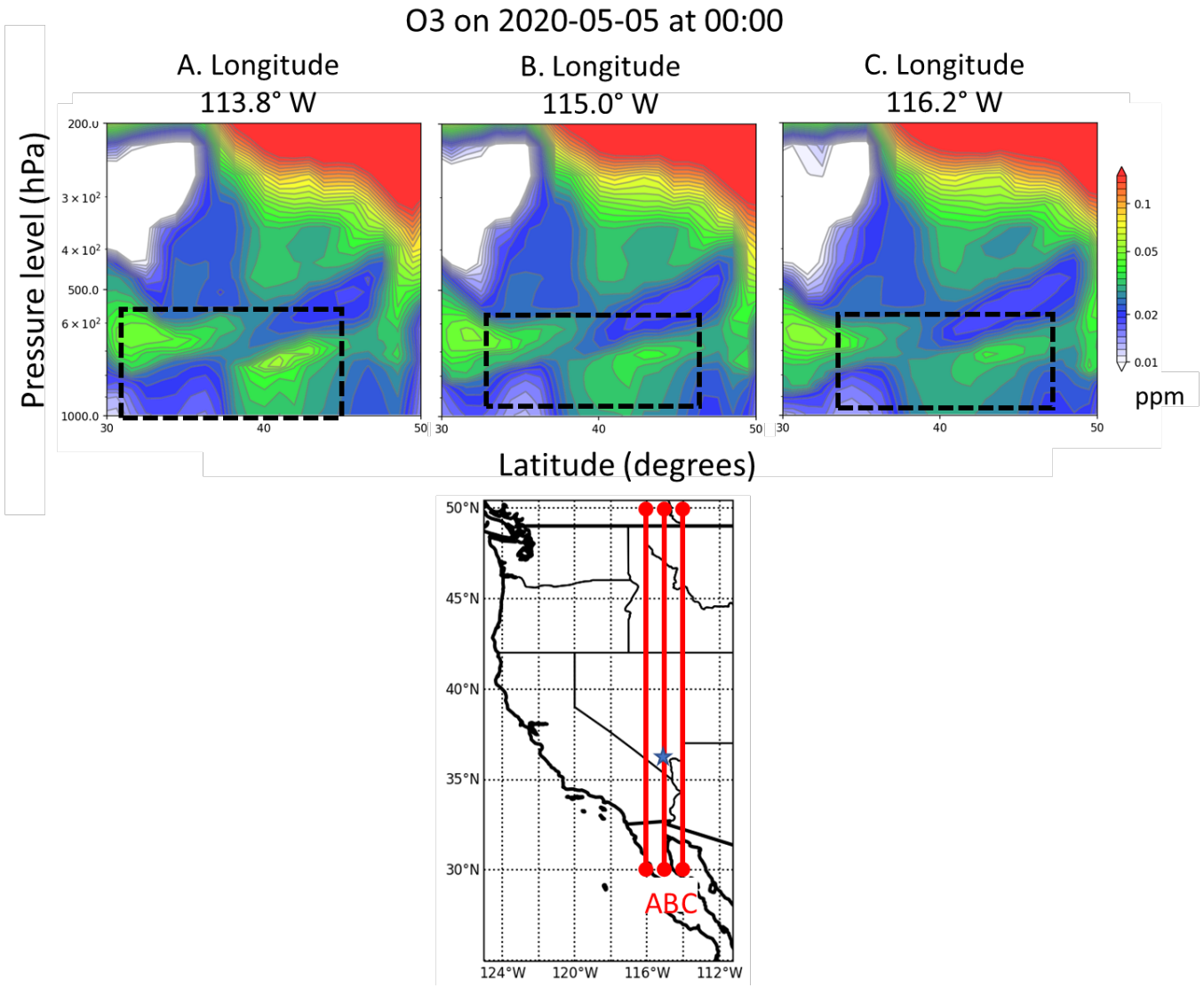

Figure A-11. WACCM-modelled cross-section of the stratospheric ozone tracer along the (A) 113.8-, (B) 115.0, and (C) 116.2-degrees W longitude line on May 5 at 00:00 UTC. The layer of ozone injected from the stratosphere is boxed in black. The extent of each cross-section is represented by the red lines (labelled by letter) on the map (bottom). Las Vegas is represented by a blue star.

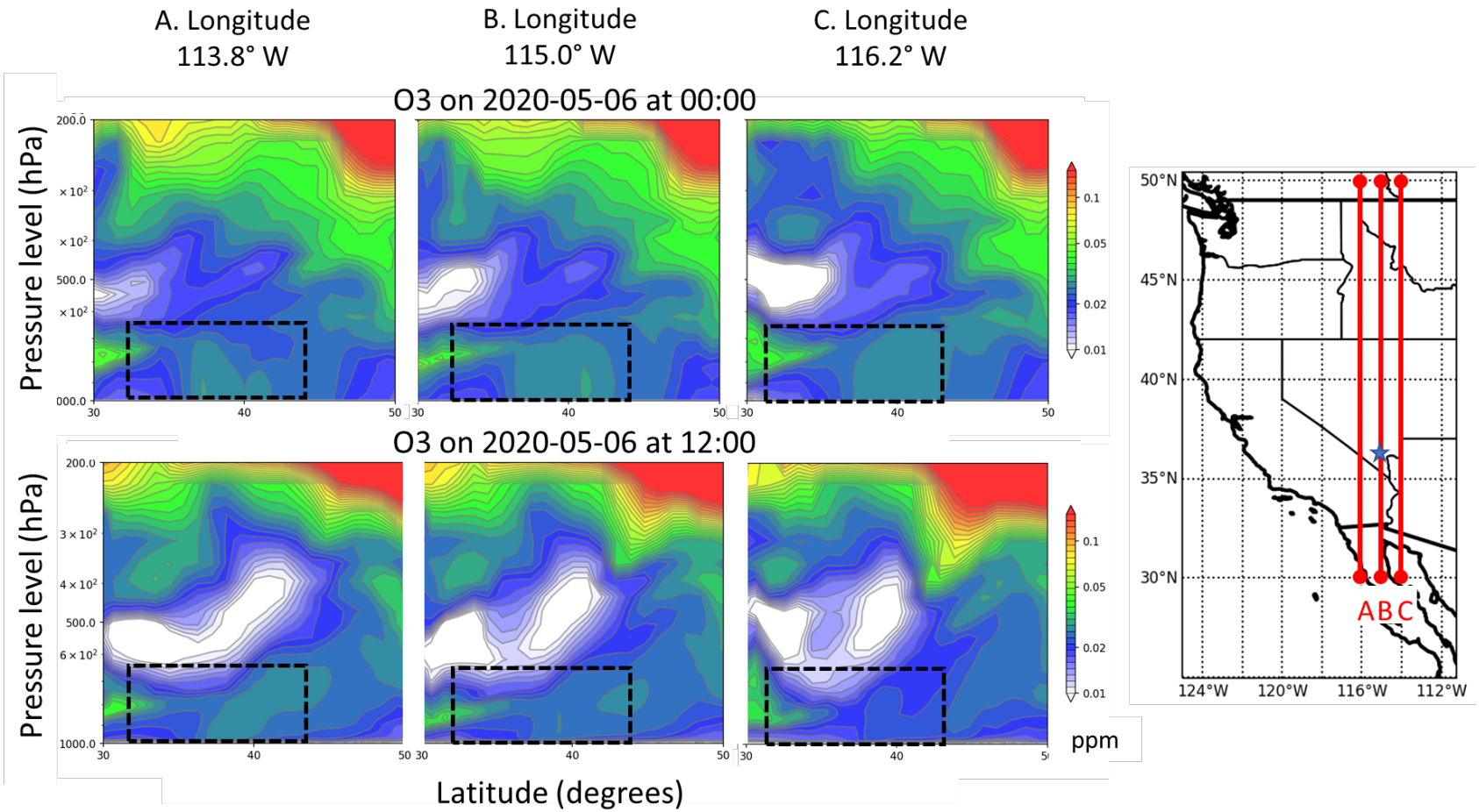

Figure A-12. WACCM-modelled cross-section of the stratospheric ozone tracer along the (A) 113.8-, (B) 115.0, and (C) 116.2-degrees W longitude line on May 6 at 00:00 UTC (top panel) and May 6 at 12:00 UTC (bottom panel). The layer of ozone injected from the stratosphere is boxed in black. The extent of each cross-section is represented by the red lines (labelled by letter) on the map (right). Las Vegas is represented by a blue star.

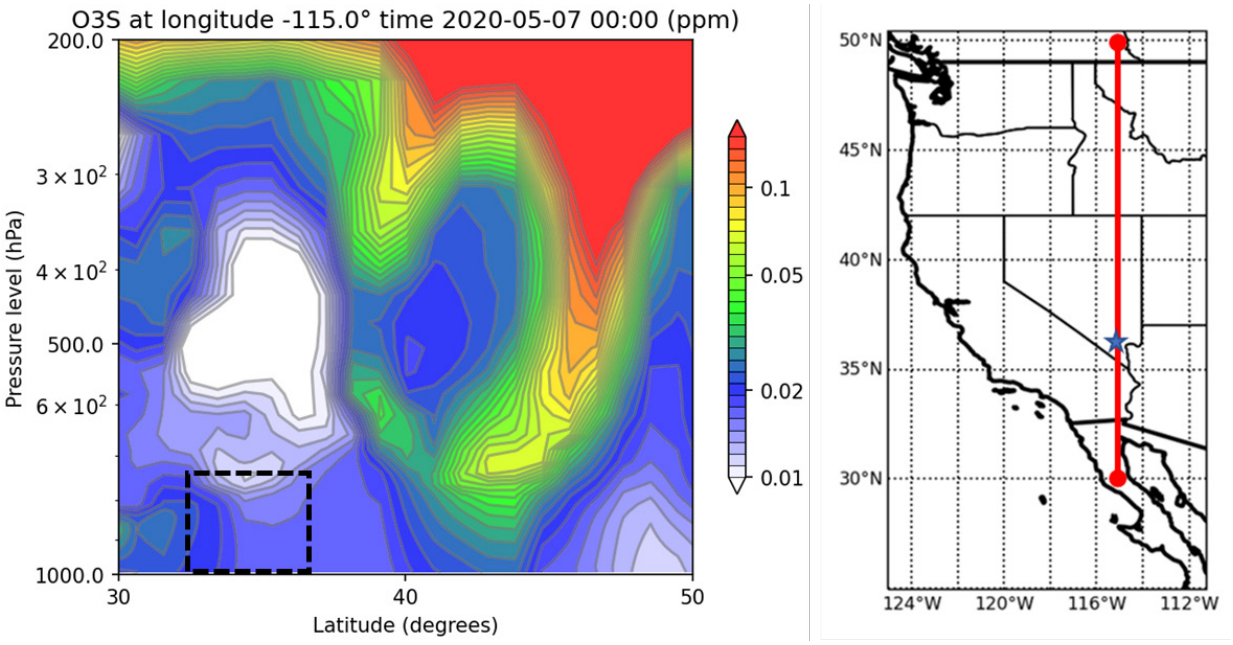

Figure A-13. WACCM-modelled cross-section of the stratospheric ozone tracer along the 115-degrees W longitude line on May 7 at 00:00 UTC, the exceedance event date (May 6, 16:00 local time). The extent of the cross-section is represented by the red line on the map (right). Las Vegas is represented by a blue star.

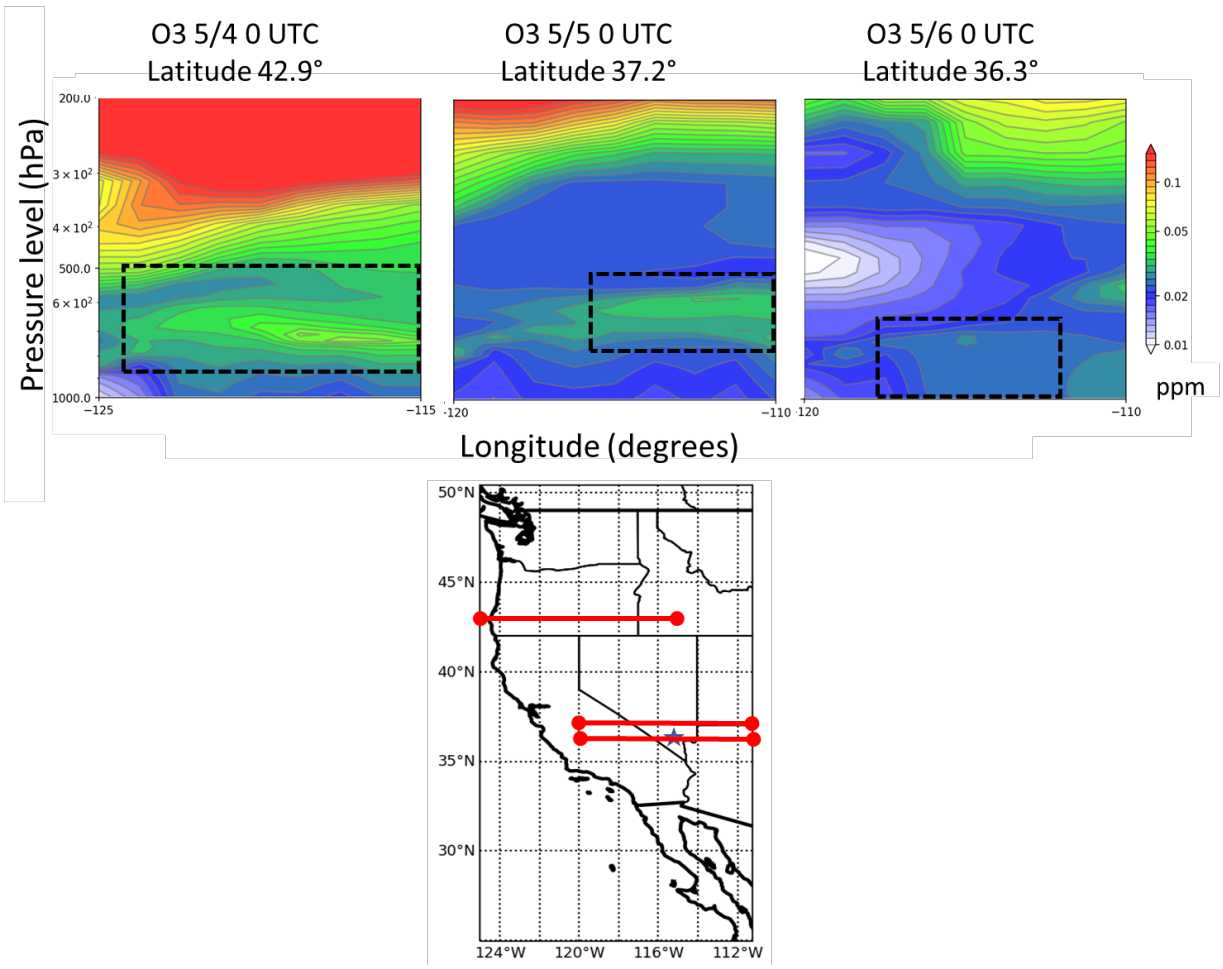

Figure A-14. WACCM-modelled cross-section of the stratospheric ozone tracer along the (A) 42.9-, (B) 37.2, and (C) 36.3-degrees N latitude lines on May 4, 5, and 6 respectively at 00:00 UTC. The extent of each cross-section is represented by the red lines (labelled by letter) on the map (right). Las Vegas is represented by a blue star. The boxed layer in A shows a tropospheric fold and elevated ozone in the mid-troposphere over the source region. The boxed layer in B shows elevated mid-tropospheric ozone in the transport path between the source region and Clark County. The boxed area in C shows a deep layer of elevated ozone between the surface and 600 mb.

References

Chouza F., Leblanc T., Brewer M., Wang P., Piazzolla S., Pfister G., Kumar R., Drews C., Tilmes S., and Emmons L. (2020) The impact of Los Angeles basin pollution and stratospheric intrusions on the surrounding San Gabriel Mountains as seen by surface measurements, lidar, and numerical models. *Atmos. Chem. Phys. Discuss.*, 2020, 1-29. Available at https://acp.copernicus.org/preprints/acp-2020-1208/.

Appendix B. Figures and Tables Supporting Section 3.5.1 (Matching Day Analysis)

Identification of matching (meteorologically similar) days includes a comparison of meteorology maps between May 6 and each date subset from candidate matching days. Surface maps for May 6, 2020, and each date listed in Table 3-15 show highly consistent conditions, with a surface low pressure system over Clark County. Surface maps for May 6, 2020, and each date in Table 3-15 in Section 3.5.1 of the report are shown in **Figure B-1 through Figure B-10**. Each upper-level map shows a ridge to the north and upper-level high pressure to the south. 500-mb maps for May 9, 2020, and each date in Table 3-15 are shown in **Figure B-11 through Figure B-20**.

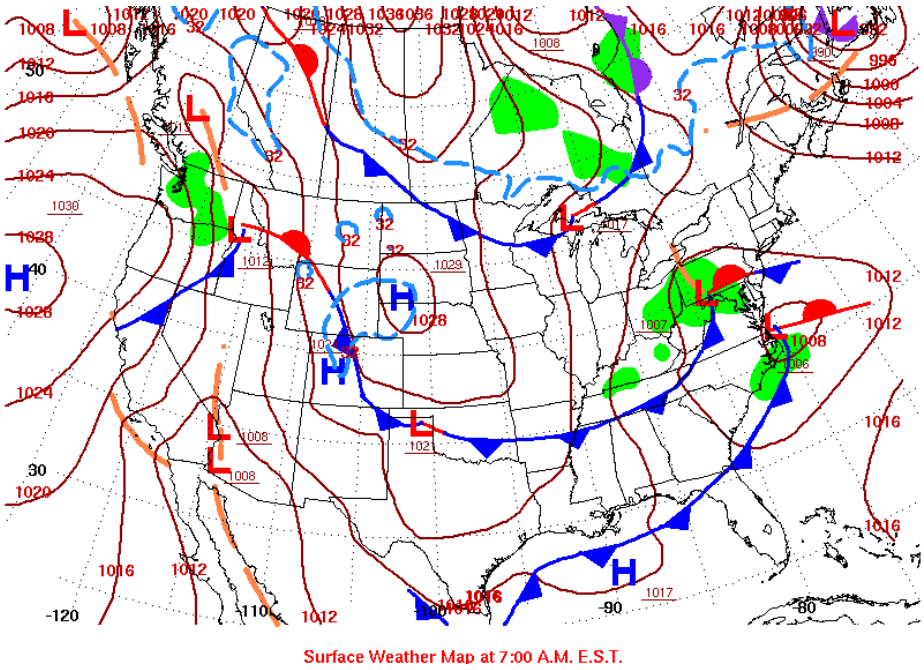

Figure B-1. Surface meteorology map on May 6, 2020 (the event date).

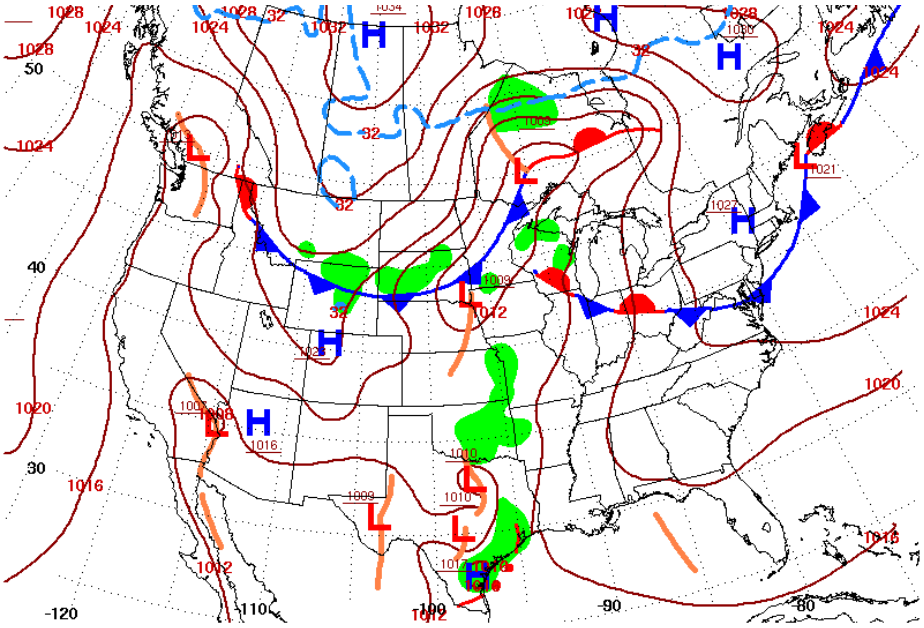

Figure B-2. Surface meteorology map on May 29, 2015.

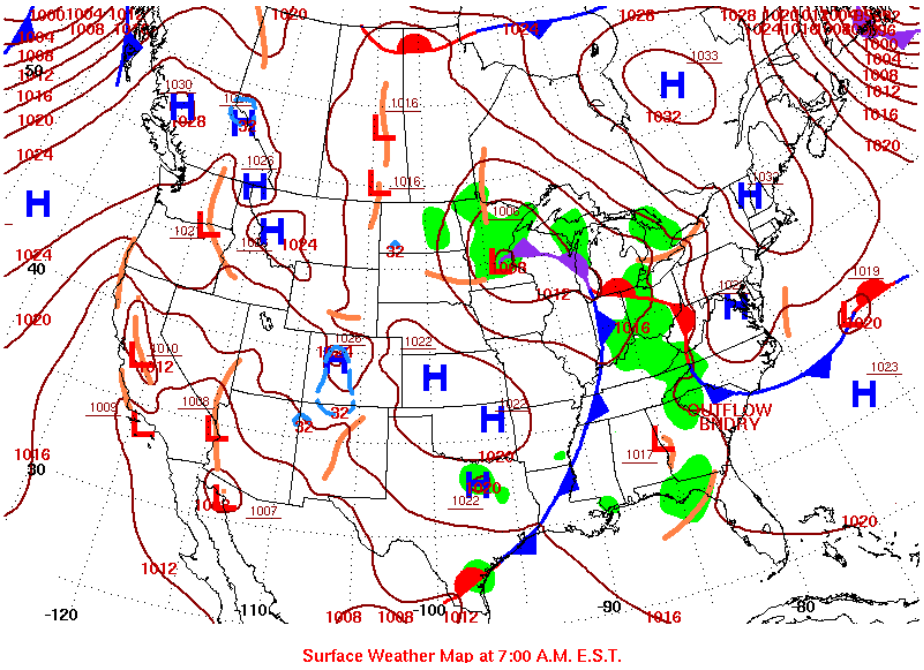

Figure B-3. Surface meteorology map on May 21, 2017.

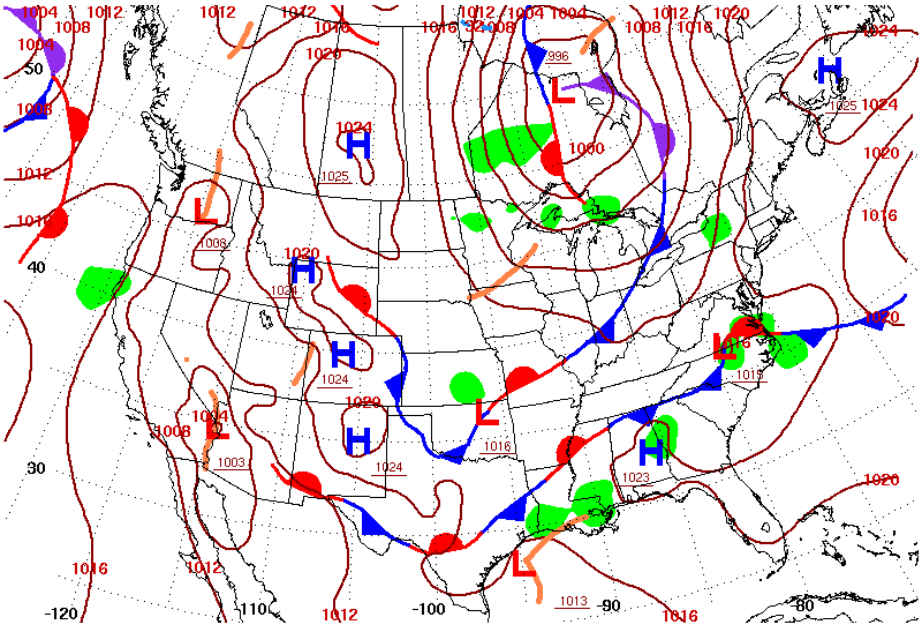

Figure B-4. Surface meteorology map on May 30, 2017.

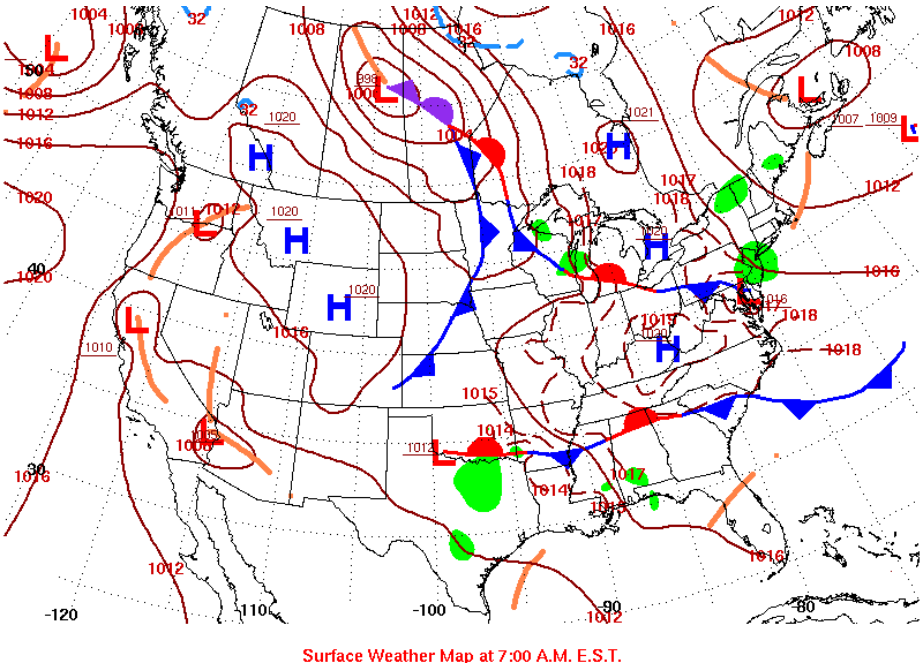

Figure B-5. Surface meteorology map on June 3, 2017.

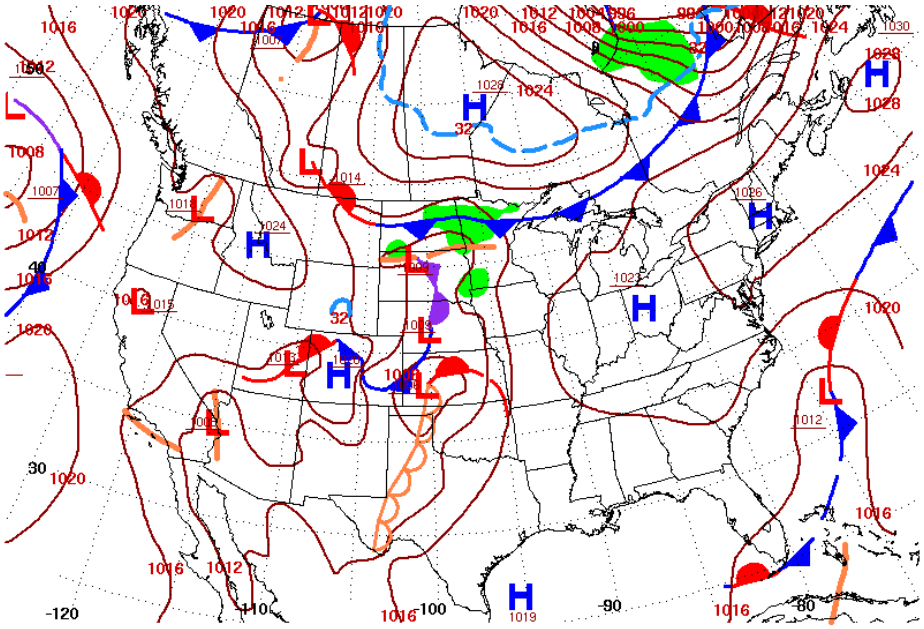

Figure B-6. Surface meteorology map on May 8, 2018.

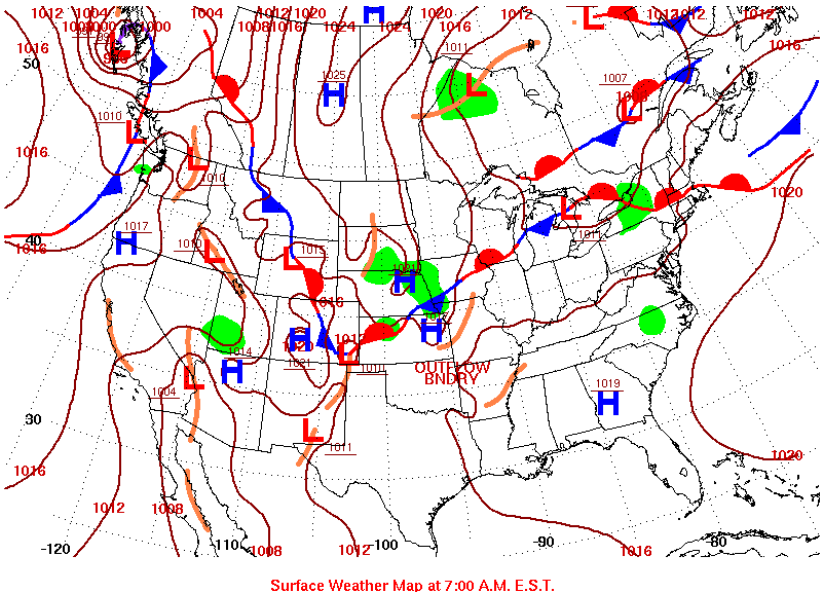

Figure B-7. Surface meteorology map on August 21, 2019.

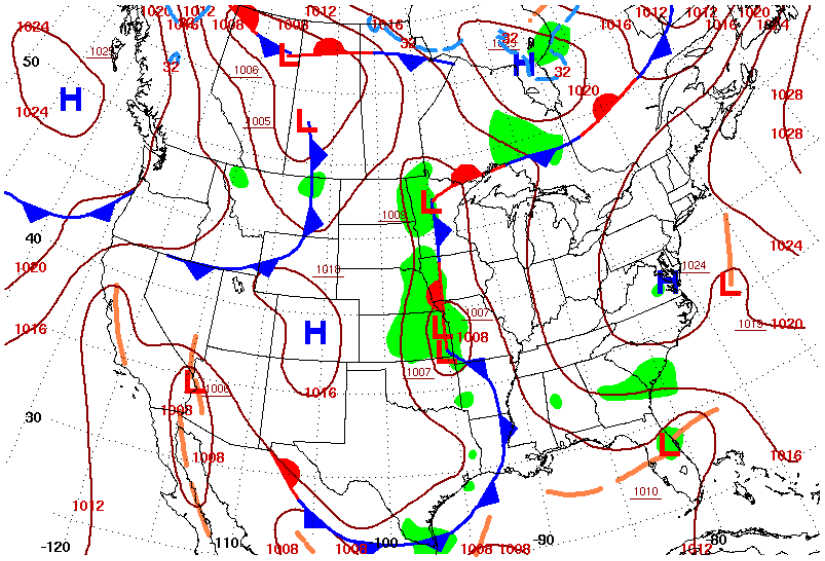

Figure B-8. Surface meteorology map on May 26, 2020.

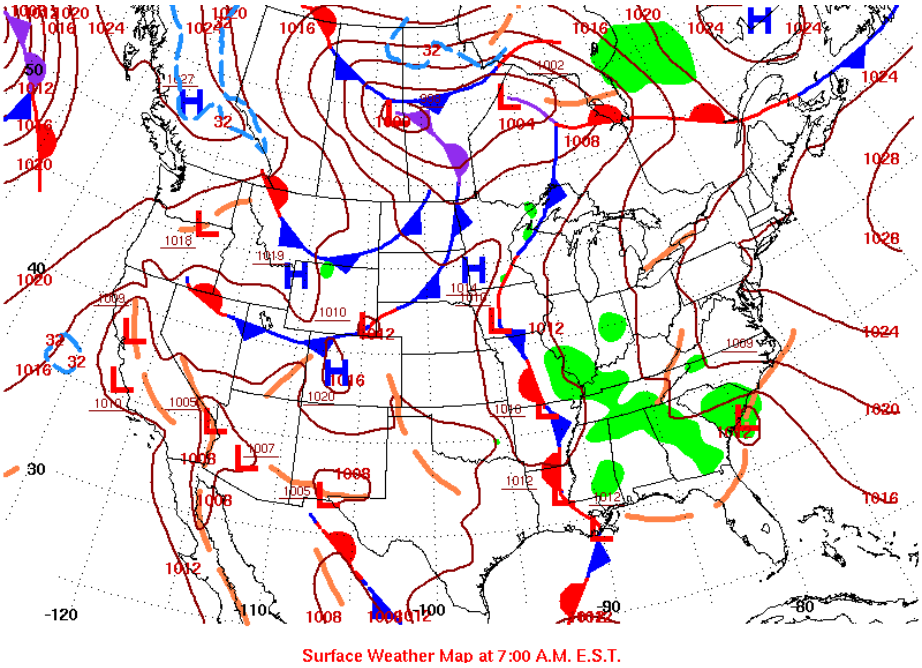

Figure B-9. Surface meteorology map on May 27, 2020

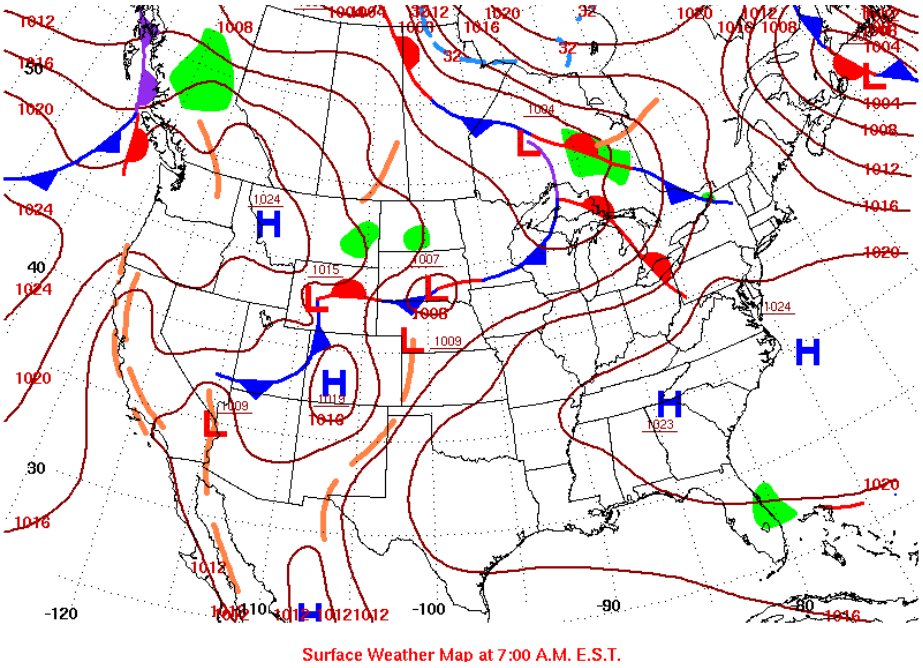

Figure B-10. Surface meteorology map on June 2, 2020.

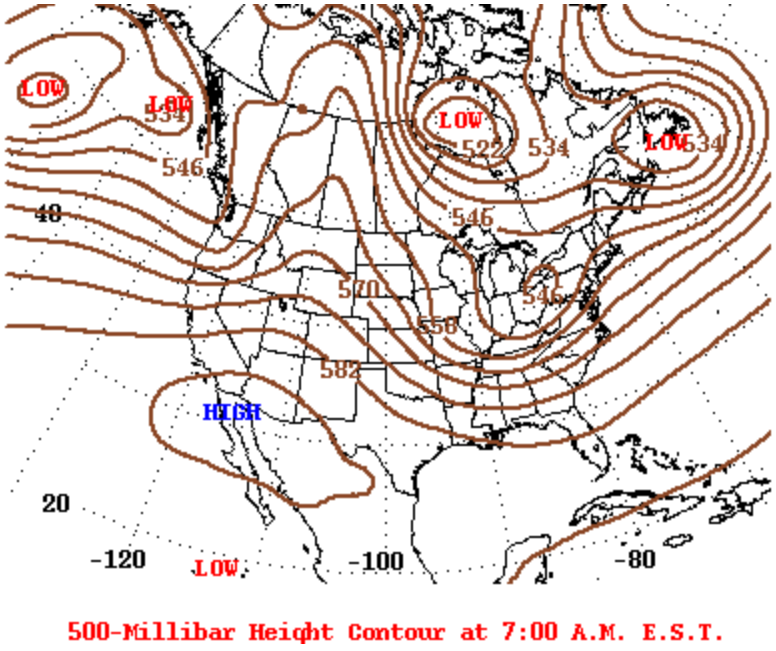

Figure B-11. 500 mb meteorology map on May 6, 2020 (the event date).

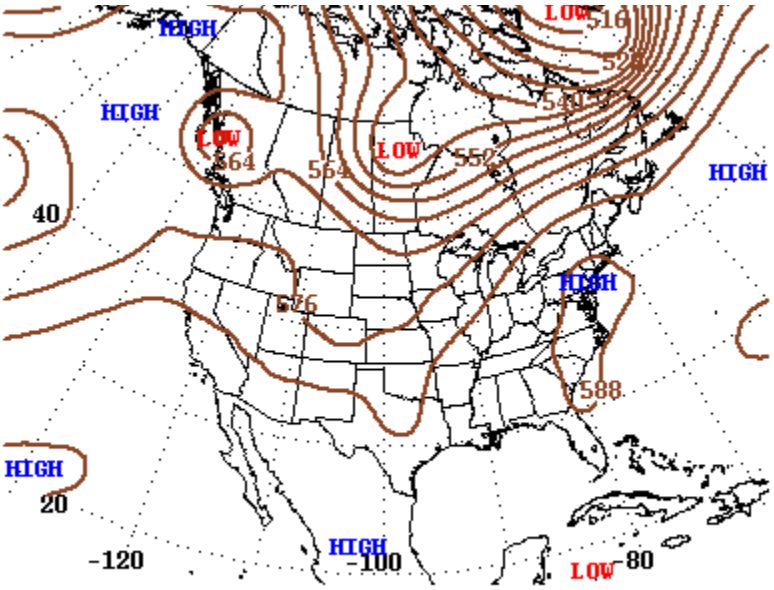

Figure B-12. 500-mb meteorology map on May 29, 2015.

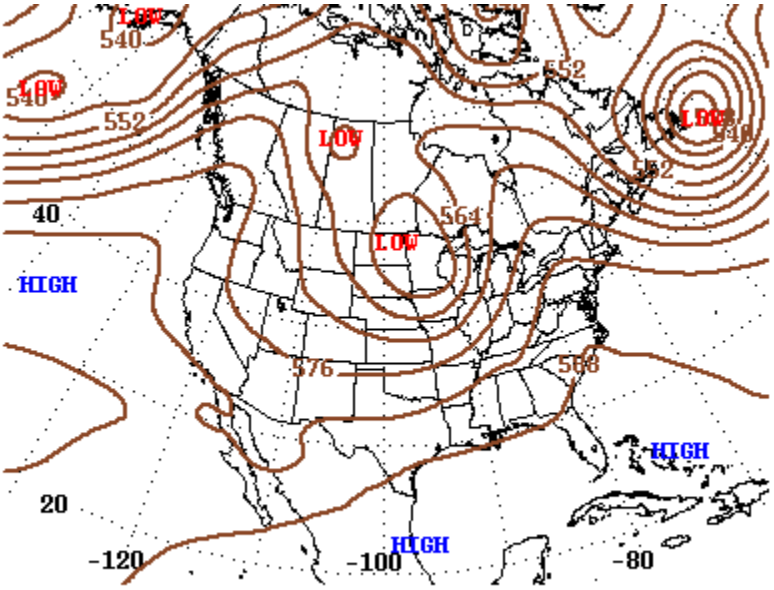

Figure B-13. 500-mb meteorology map on May 21, 2017.

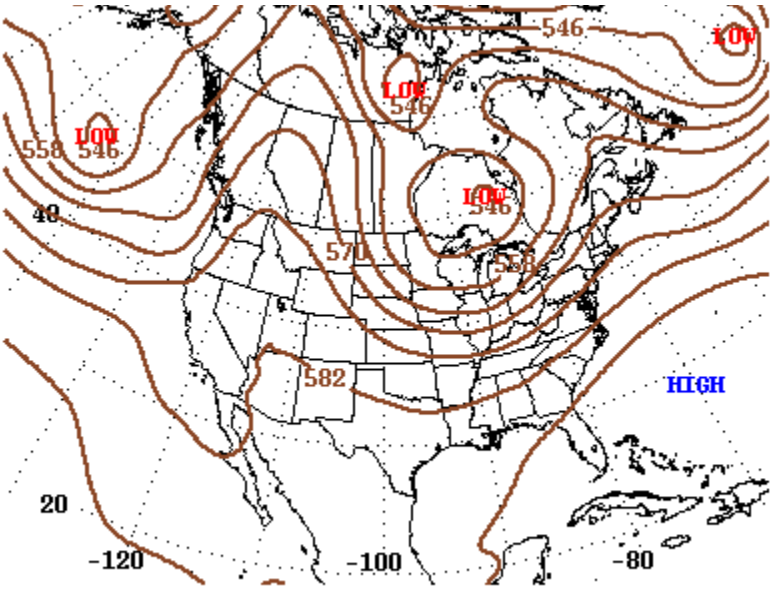

Figure B-14. 500-mb meteorology map on May 30, 2017.

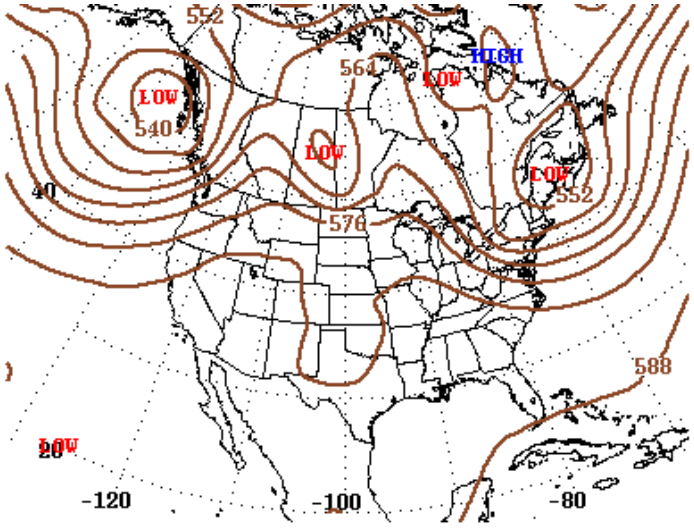

Figure B-15. 500-mb meteorology map on June 3, 2017.

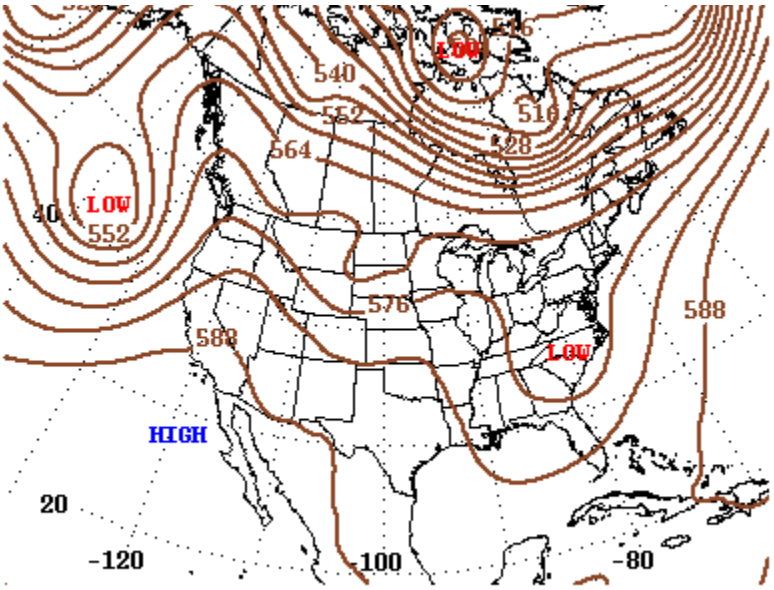

Figure B-16. 500-mb meteorology map on May 8, 2018.

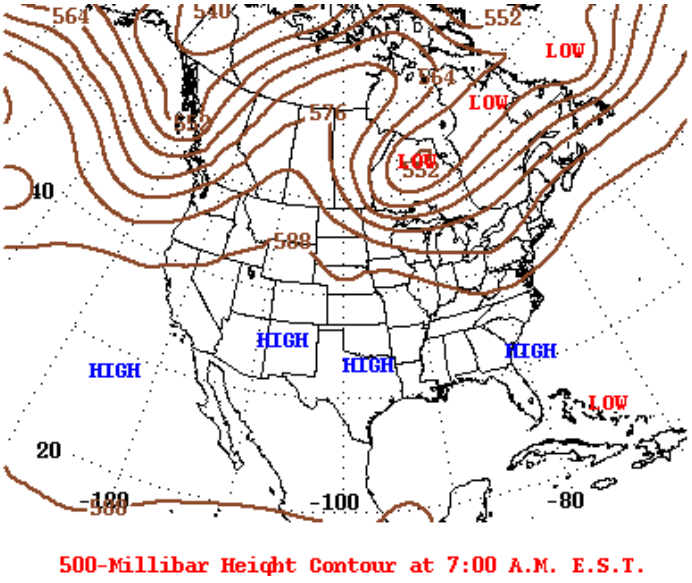

Figure B-17. 500-mb meteorology map on August 21, 2019.

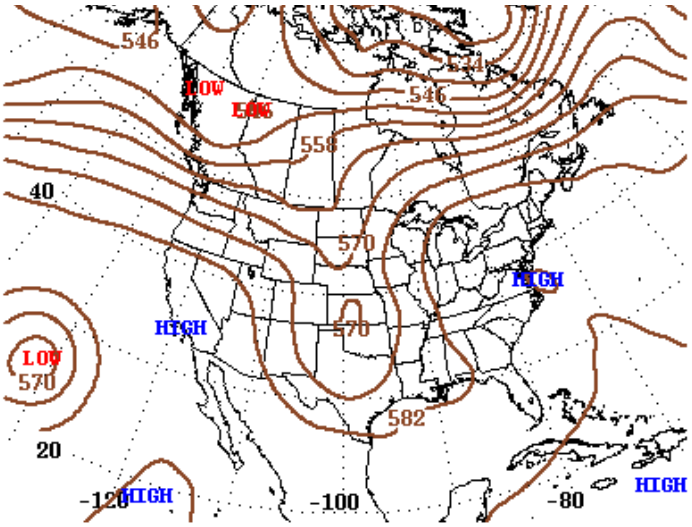

Figure B-18. 500-mb meteorology map on May 26, 2020.

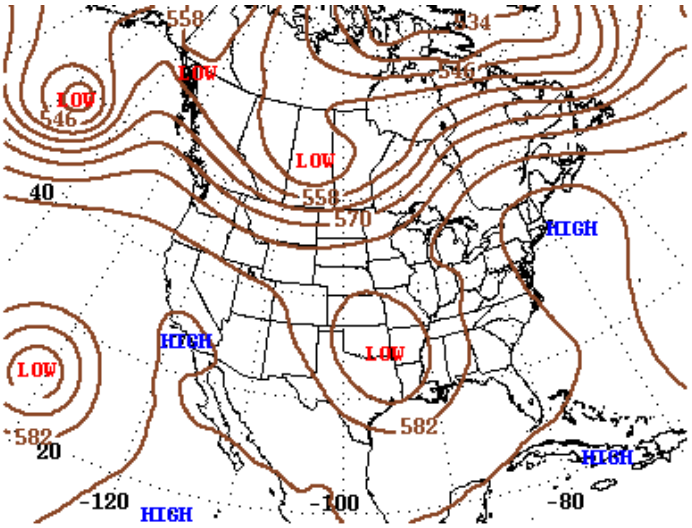

Figure B-19. 500-mb meteorology map on May 27, 2020.

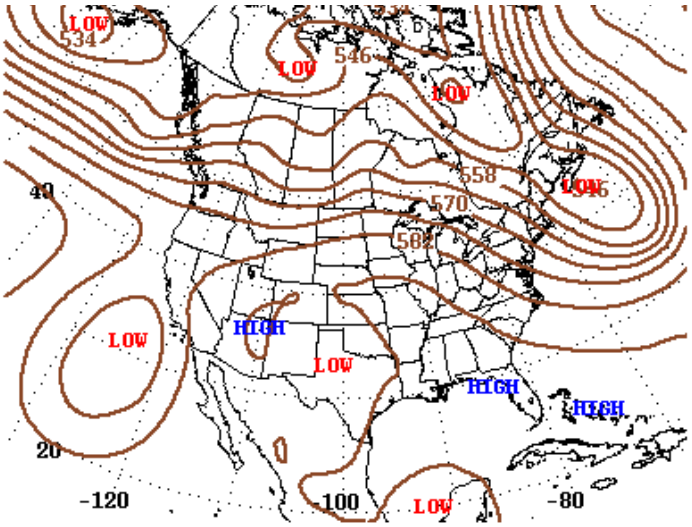

Figure B-20. 500-mb meteorology map on June 2, 2020.

Appendix C. GAM Residual Histograms and Scatter Plots from Concurred Exceptional Event Demonstrations

The following are GAM residual histograms and scatter plots from the concurred Arizona Department of Environmental Quality demonstration (Arizona Department of Environmental Quality 2016) and the submitted Texas Commission on Environmental Quality demonstration (Texas Commission on Environmental Quality 2021) for comparison with our GAM residual analysis. The figures in this Appendix show the good residual results from concurred and currently submitted exceptional events demonstrations to which we compared our results. Based on this comparison, we suggest that our GAM results show a well-fit, unbiased model. A well-fit GAM model should show a normal distribution of residuals at all sites modeled (ADEQ example in **Figure C-1**) and show no pattern or bias between GAM residuals and predicted values (TCEQ example in **Figure C-2**). These figures compare well with our GAM results in Section 3.5.2 of the main report.

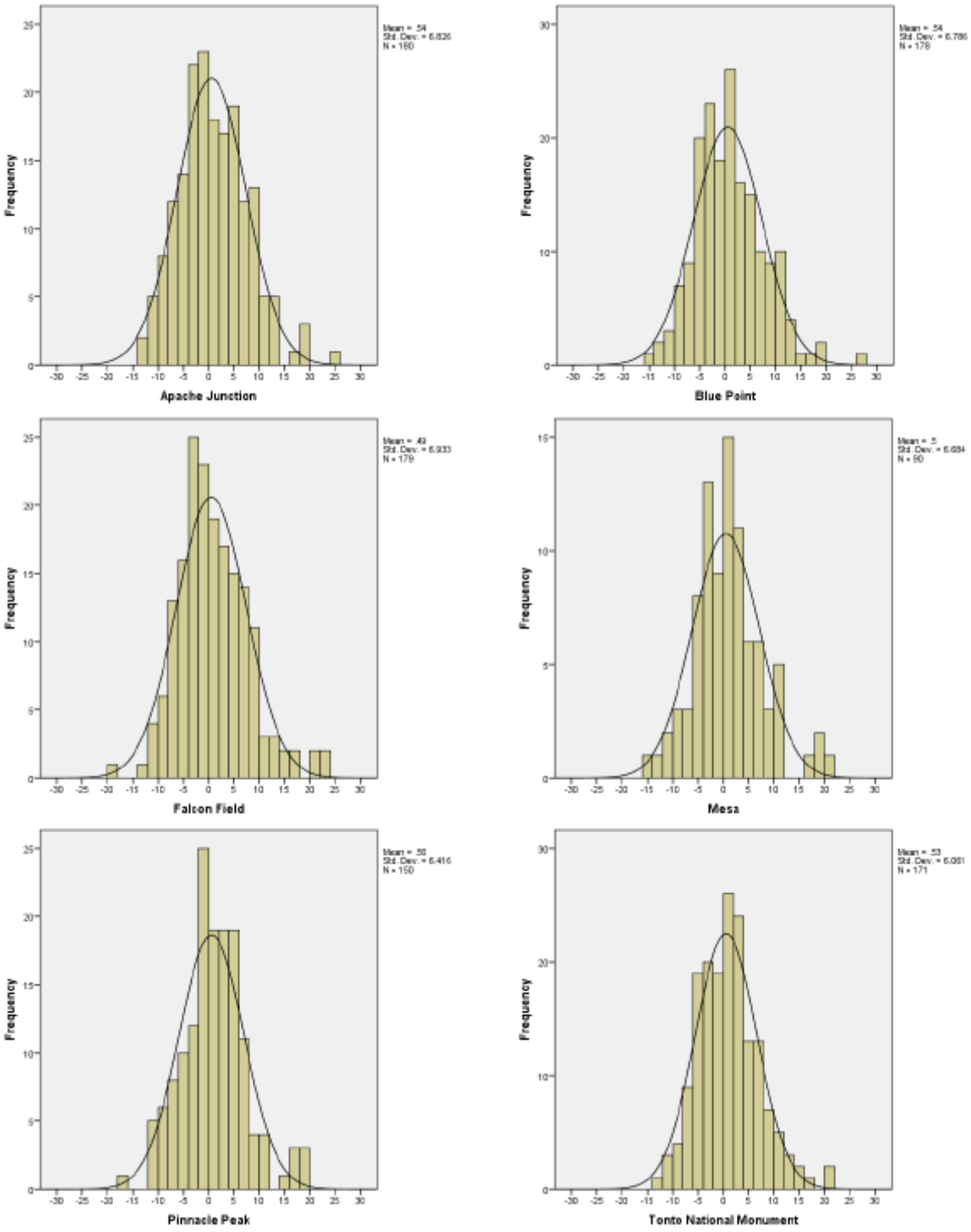

Figure C-1. Histograms of residuals results at each monitoring site from the Arizona DEQ GAM Analysis (Arizona Department of Environmental Quality 2016).

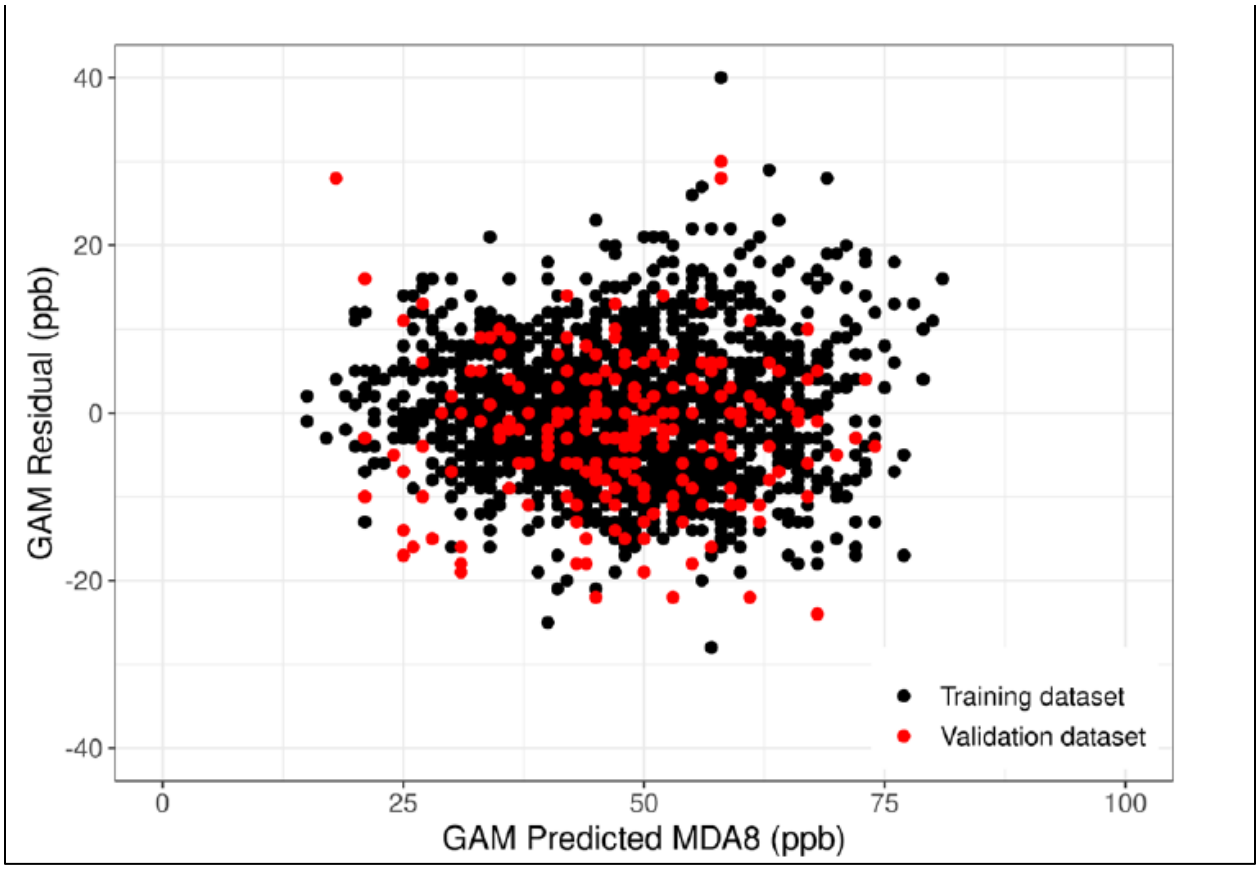

Figure C-2. Scatter plot of GAM residuals (observed – GAM predicted MDA8 ozone) vs. GAM predicted MDA8 ozone from the TCEQ submitted GAM analysis. Training data is shown in black, and validation data is shown in red (Texas Commission on Environmental Quality 2021).

References

Arizona Department of Environmental Quality (2016) State of Arizona exceptional event documentation for wildfire-caused ozone exceedances on June 20, 2015 in the Maricopa nonattainment area. Final report, September. Available at https://static.azdeq.gov/pn/1609_ee_report.pdf.

Texas Commission on Environmental Quality (2021) Dallas-Fort Worth area exceptional event demonstration for ozone on August 16, 17, and 21, 2020. April. Available at https://www.tceq.texas.gov/assets/public/airquality/airmod/docs/ozoneExceptionalEvent/2020-DFW-EE-Ozone.pdf.

Appendix D. Documentation of the Public Comment Process

To be updated once the public comment period has concluded.